

Summer 2002

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L. K. Doraiswamy

of Iowa State University

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L. K. Doraiswamy came to Iowa State University (ISU) in a most unusual manner. One of the authors (PR) was attending a meeting in New Delhi in 1984 and, since he had previously helped two scientists at the National Chemical Laboratory (NCL) in Pune with some chromatography for a project of theirs, he asked if he could visit them there. He took the train to Pune during the dry season, arriving a bit hot and dusty, but quite exhilarated after experiencing one of the world's great train rides—the climb through the Western Ghats. He and a former graduate student were picked up by two NCL scientists on their motor scooters and were delivered to the laboratory, where they were eventually ushered into the baronial office of the NCL Director, occupied in fine style by one L.K. Doraiswamy. Although L.K. was chagrined that the visitors had not been met by an air-conditioned NCL car, things went so well after that, the ISU visitor ended by participating in a joint enzyme project with the NCL.

Some years later, L.K. (as he is known to his friends and colleagues, except at Wisconsin-Madison where he goes by Dorai) arrived by very small plane in Des Moines to see how the ISU end of the joint project was progressing. During that visit L.K. was asked by his host what he planned to do after his (imminent) NCL retirement. L.K. mentioned how much he liked small midwestern university towns, and sensing a very good thing, the host passed this word on to his department chair (Dick Seagrave). Soon an appointment was hurtling through the university hierarchy in record time.

That first appointment, in 1989, was the Glenn Murphy Chair, meant for a distinguished visiting professor in the College of Engineering. It was followed by the Department of Chemical Engineering's Herbert Stiles Chair in 1992, and then in 1996 L.K. became Anson Marston Distinguished Professor in Engineering. His first office was anything but baronial, being the standard 120 ft² with hardly any window area, but eventually a nice office opened up when Sweeney Hall was expanded. L.K. still occupies it, even after his retirement from ISU in December 2000.

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EARLY STIRRINGS

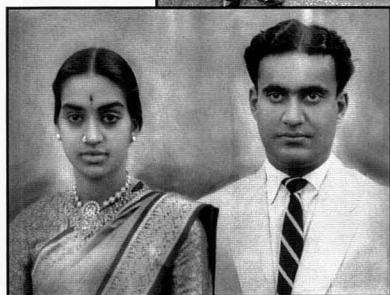
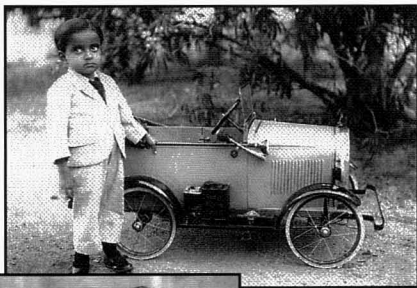
L.K. was born in Bangalore in 1927 to L.S. and Kamala Krishnamurthy, the only boy of four children. His father led the Hyderabad Branch of the Geological Survey of India. For part of his childhood, L.K. and his family lived in the small village of Lingsagur. Later they moved to Hyderabad, the state capital, where L.K. graduated from Methodist Boys High School. He studied chemistry at Nizam College in Hyderabad, part of the University of Madras, and then was faced with several opportunities for further education. One was to study organic chemistry, a subject he thoroughly enjoyed. But the rapidly developing field of chemical engineering also attracted him, and he ultimately decided to study it at the Alagappa Chettiar College of Technology, also part of the University of Madras. Such an opportunity was very rare in India at the time, since only two schools with limited enrollments and very high entrance standards offered chemical engineering.

ON TO WISCONSIN

As a result of his successful record in pursuing chemical engineering at Madras, L.K. received a scholarship from the Hyderabad government to study in the United States. An uncle with a Wisconsin PhD in chemistry suggested that he apply there—he did, he was accepted, and he arrived during the winter cold of December 1948.

L.K. was lucky enough to secure Olaf Hougen as his major professor, and after he earned his MS in 1950 and his Indian scholarship had expired, Hougen convinced the Hyderabad government to continue funding L.K. for a PhD (which he received in 1952). His dissertation was on semichemical pulping, done under the joint supervision of Hougen and John McGovern of the USDA Forest Products Laboratory in Madison.

Hougen's perception that he had found a promising chemical engineer was even truer than he thought—in 1987 L.K. became the Olaf Hougen Visiting Professor of Chemical Engineering at Wisconsin, an honor given to only five other distinguished educators. Then in 1991, he received an honor-

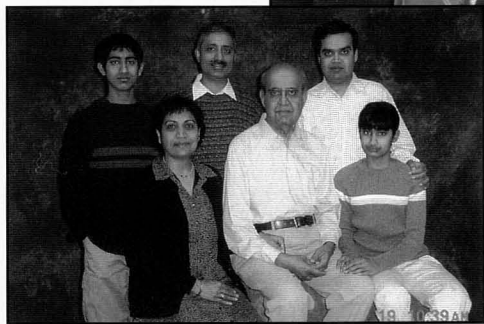
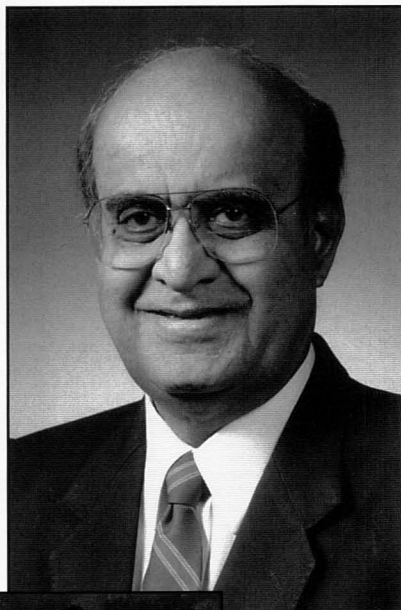


(Top) L.K. evinced a clear penchant for things mechanical at an early age.

(Above) L.K. and his wife Rajalakshmi (now deceased) after their 1952 wedding.

(Right) Today's L.K.

(Below) L.K.'s present family; left to right, Rahul, Sandhya, Sankar, L.K., Deepak, and Priya.



L.K. and six of his seven ISU doctoral students. From the left, Leigh Hagenson Thompson, L.K., Sanjeev Naik, Holger Glatzer, Jennifer Anderson, Ore Sofekun, and Sridhar Desikan. Missing is Justinus Satrio.

ary DSc from Wisconsin to go with his 1982 honorary DSc from Salford in England.

BACK HOME TO THE NATIONAL CHEMICAL LABORATORY

After graduating from Wisconsin, L.K. worked on emulsion paints for a year at Carlisle Chemical and Manufacturing in Brooklyn. Although the company urged him to stay, L.K. believed he could make a greater contribution in India, and in 1954 he joined the NCL as a senior scientist. He rose rapidly through the ranks, becoming Assistant Director and head of the Division of Organic Intermediates and Dyes in 1961, Deputy Director and head of the Division of Chemical Engineering and Process Development in 1966, and finally becoming Director in 1978. He was the fifth director and the first nonchemist to head the NCL, and he led it until he retired in 1989. After his retirement, he came to the United States to be nearer to his children and grandchildren, and (not incidentally) to continue his research career without the burden of administrative duties.

L.K. had a tremendous impact on NCL, both as a tireless and innovative researcher and as a highly respected and visionary leader who promoted research excellence. When he retired he received a scroll that reviewed his accomplishments and summed up his contributions by stating, "You epitomize the finest in scientific research, management, planning, and execution. We will always remember you, as a compassionate human being who combined in himself the attributes of great scholarship and visionary leadership." His contributions to the growth of the Indian chemical industry were also cited, as was his extensive service as an advisor to the Indian government and as a member of various key committees.

Early in his NCL tenure, L.K. established a strong base of fundamental and applied research, especially in chemical reaction engineering. Under his leadership, many commercially important technologies were developed, including fluidized-bed processes for making chloromethanes and methylchlorosilanes, continuous processes for dimethylaniline and ethylenediamine, a new process for vitamin B₆, and a complete process for methyl, ethyl, butyl, and 2-ethylhexyl acrylates. The dimethylaniline technology was the first vapor-phase catalytic process for making that product, while that for ethylenediamine was apparently the first continuous organic chemical process developed in India. His teams also developed zeo-

lite catalysts and processes for xylene isomerization and for making alkylating benzene with alcohols. Many of these developments led to awards from the Indian Chemical Manufacturer's Association.

L.K. lavished care and attention on the NCL by streamlining departments, doing what was needed to attract the best people, and attending to the needs of the whole community. His son Deepak tells us that on occasion this involved such matters as "compassionate appointments" for poor or recently widowed employees, special housing allotments for deserving cases, and investment of resources for welfare purposes such as the local school and a shopping center (which has since become a major attraction in the city and is named after his late wife).

To highlight his human side, one instance is worth special mention. One night, a poor family was evicted from the NCL campus for building and occupying an illegal accommodation. L.K., moved by their plight (and against the administrative officer's advice), gave them permission to stay overnight until they could make other arrangements. This eventually led to a protracted legal battle and illustrates how his softer side sometimes leads him to take risks.

His professionalism concerning matters such as punctuality, returning phone calls, meeting deadlines, and making allowances for potential mistakes in planning is also a hallmark of his character. His approach is simply "to get and maintain the best," and it has led to a legacy of excellence that he is especially proud of. He maintains that "excellence is a state of mind" and he never tires of repeating it.

While at NCL, L.K. wrote a book on catalytic reactors and reactions (Pergamon, 1991) and was coauthor of two vol-

umes on heterogeneous reactions with his close friend M.M. Sharma at the University of Bombay (Wiley, 1984) and one on stochastic modeling with his NCL colleague B.D. Kulkarni (Gordon and Breach, 1987). He also edited or coedited four books and contributed chapters to six others. L.K. personally guided the thesis research of 45 students who received PhDs from various Indian universities and collaborated with the late Tony Holland at Salford in guiding fifteen others and with Mike Davidson at Edinburgh in an additional two. He has been author or coauthor of some 155 international journal articles. They were mainly on adsorption and catalysis; gas-solid, gas-liquid, solid-solid, and slurry reactions; fluidization; and stochastic modeling and analysis of reacting systems. For five years he also served as editor of the *Indian Chemical Engineer*.

L.K. is reputed to have received every major scientific and technical award in India open to chemical engineers. Among the most noteworthy are the Om Prakash Bhasin Award for Science and Technology, given by Indian President Zail Singh in 1986, the Jawaharlal Nehru Award for lifetime achievement in engineering and technology (1987), and the Republic Day honor Padma Bhushan presented by Indian President R. Venkataraman in 1990. Notable awards from outside of India but honoring his work there are election to the Third World Academy of Science in 1997, the Richard H. Wilhelm Award from AIChE in 1990, and the Personal Achievement in Chemical Engineering Award in 1988 from *Chemical Engineering* magazine.

THE FAMILY MAN

Soon after returning to India, L.K. married his wife Rajalakshmi. She was always a source of great emotional

Students and faculty at the Wisconsin summer laboratory course in 1977, with L.K. at the far right and Roger Altpeter and Richard Grieger-Block at the far left. Wisconsinans, and others, beyond a certain age will enjoy identifying the others pictured here.



strength and happiness to him, and her early death after a prolonged and painful illness was a devastating blow. L.K. has two children, Sandhya and Deepak, who remember their dad teaching them by gentle example and with the adage that discipline is doing what you don't like to do. Sandhya completed a MPhil at the University of Poona and became a CPA after she arrived in the United States. She and her husband Sankar Raghavan have two children, Rahul and Priya, the apples of their grandfather's eyes. L.K.'s son Deepak received a PhD in chemical engineering from Delaware after earning a BTech from the University of Bombay. He completed a postdoctoral fellowship in the Rutgers Department of Ceramics and Materials Engineering and then joined the DuPont Experimental Station in Wilmington, Delaware. He is also an adjunct professor at West Virginia University. L.K.'s children and the department at ISU engage in a gentle tug-of-war over where L.K. will live in retirement. So far, to our delight, he remains in Ames, with frequent trips east.

Deepak tells us that true to his sense of filial and family responsibility, L.K. took under his wing his parents, an unmarried sister, and a widowed sister and her children, all while supporting his own young wife and two small children.

L.K. is a lover of the English language, both written and spoken. He writes beautifully and his spoken English is free of slang and interjections. He is a purist about word usage and delights in good sentence construction. As a child, his school principal advised him to become an author, if possible, and he managed to do that, although certainly not in the manner the former expected.

A SECOND CAREER

Starting a second career at ISU in 1989 did not slow L.K.'s pace at all. In fact, relinquishing administrative duties at the NCL gave him a second wind. He has continued to thrive through his writing, lecturing, teaching, and research. He taught undergraduate and graduate chemical reaction engineering courses, established a new research program from scratch, and guided the research of seven ISU doctoral students.

L.K.'s research has focused primarily on chemical reaction engineering, especially on rate enhancement strategies in organic synthesis. His group was worked on phase transfer catalysis and has showed that many of its problems can be overcome by immobilizing the catalyst on a polymer support. They have developed and published new mathematical models and have investigated the effect of ultrasound on solid-liquid reactions mediated by phase transfer catalysts. In addition to his own seven doctoral students, L.K. collaborated with Terry King and Tom Wheelock in supervising two others. He worked with the late Mauri Larson on developing and validating a microphase-assisted reaction model, and he continues to develop an advanced calcium-based sorbent for desulfurizing hot coal gas with Tom Wheelock.

Writing and publishing continue to draw much of L.K.'s attention. He has published 25 research papers and several comprehensive reviews, mainly in *Chemical Engineering Science* and *IEC Research*, while at ISU. At the same time, he was absorbed in writing his 26-chapter *Organic Synthesis Engineering*, published by Oxford University Press in 2001. The book integrates synthetic organic chemistry with chemical engineering through many illustrative examples, so it will benefit both chemists and engineers who work together on manufacturing processes.

L.K. was also honored by a special session at the 1997 AIChE Annual Meeting in Los Angeles and by the publication of special collections of research papers written by many of his colleagues and friends. One of these collections appeared as the "L.K. Doraiswamy Festschrift," which honored his 70th birthday and filled the June 1998 issue of *IEC Research*. The Indian Academy of Sciences published an earlier collection, titled "Reactions and Reaction Engineering," to mark his 60th birthday. In spite of these accolades, L.K. remarked in the preface to *Organic Synthesis Engineering*: "If the truth be told, I am not sure to this day whether I learned more from my students at NCL and ISU or they from me."

To further honor L.K.'s contributions in both the United States and India, ISU and NCL established a Doraiswamy Honor Lectureship, filled by a distinguished chemical engineer who annually delivers lectures at both places. The first three lecturers have been Jimmy Wei (Princeton), Alex Bell (UC Berkeley), and Klavs Jensen (MIT). It was the first exposure to India for all three.

Along with L.K.'s ISU Distinguished Professorship came the Margaret Ellen White Graduate Faculty Award (2000) for superior mentoring of graduate students. Selection for this honor reflects the sentiments of a former student, who wrote "The dedication, persistence, and attention to detail that I learned from Dr. Doraiswamy has guided me in more ways than I ever dreamed possible." L.K. not only has a high regard for students but also enjoys assisting and working with them without completely solving their technical problems. He is well known for inviting groups of students to his home for serious as well as humorous discussions of science, philosophy, and politics, subjects in which he has deep interest.

One of his graduate students sums up quite nicely the mentor-teacher-friend we know as L.K.: "In addition to being a fine research mentor, I found Dr. Doraiswamy to be a caring individual. I was able to talk with him about other things outside my research—even some personal matters. The well-being of his students was also Dr. Doraiswamy's concern. There was a period of time when I had been struggling with my health. Whenever we met, Dr. Doraiswamy would ask me about my health. When I mentioned this to a research group colleague, he said 'That's funny. Dr. Doraiswamy always asks me whether my old car is running.'" □